

## Notes on the Ferns of the Eastern United States

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In September, 1946, Dr. H. A. Gleason, of the New York Botanical Garden, invited me to prepare the treatment of the ferns and fern allies for his new Illustrated Flora. Dr. William R. Maxon had worked up the ferns for the second edition of Britton and Brown's Illustrated Flora. Dr. Maxon had been invited to prepare a revision, but he did not feel up to it. I accepted and forwarded the completed manuscript in December, 1948 (some corrections and additions were forwarded in January, 1950).

The work, although it covers the same ground as Dr. Maxon's treatment, is essentially my own, for all the descriptions and keys were redrawn. Dr. Maxon would perhaps not always agree with my treatment. Now that Dr. Gleason's work is about ready to be published it seems desirable that I should give in advance some explanation of my treatment of certain groups, especially since a few new combinations are needed.

I am reviewing elsewhere Professor M. L. Fernald's new Gray's Manual of Botany, which covers essentially the same range as Dr. Gleason's Flora. Those who are hoping for a complete agreement in the taxonomy and nomenclature of the species are going to be disappointed. It is perhaps inevitable that independent workers will not come to the same decisions, even on a group as well known as the ferns of the eastern United States. Naturally in some genera there is complete agreement between Dr. Fernald's treatment and my own; in most of the larger genera there is more or less disagreement. Dr. Fernald recognizes 130 species of native ferns and I 116.<sup>1</sup> Dr. Fernald also recognizes a great many more forms and

<sup>1</sup> Gray's Manual (7th edition) had 114, Dr. Maxon's treatment 128.

varieties than I have mentioned (in accordance with Dr. Gleason's instructions to be "temperate" in the recognition of subspecific categories). Dr. Fernald's detailed treatment of minor forms is certain to be of great usefulness.

#### GYMNOCARPIUM

For a long time now botanists have maintained the genus *Dryopteris* essentially as defined in Christensen's Index Filicum, although realizing that this vast genus might not be wholly homogeneous. Christensen himself suggested that it should be divided along natural lines. This has been done by Ching, Copeland, and others. The necessity for such a treatment will not appear obvious to some students. We have been accustomed to thinking that these plants all belong together. However, it seems likely that when we see a specimen, perhaps of a species unknown to us, and say "That is a *Dryopteris*," we are recognizing not a fundamental generic character of a genus *Dryopteris*, but a similarity to a certain species that is commonly referred to *Dryopteris*. If such species as *D. Thelypteris* and *D. noveboracensis* had always been referred to a distinct genus (e.g., *Thelypteris*) we should not perceive a very close similarity to true species of *Dryopteris*, such as *D. marginalis* or *D. Filix-mas*. In fact we should probably consider a suggestion to unite them into a single genus as preposterous. For *Thelypteris* not only has a different aspect but has distinct morphological and anatomical characters.

I have hesitated a long time before making this seemingly radical change in classification. I obtained my views on fern classification largely through my association for many years with Dr. William R. Maxon, who was notably conservative. Dr. Maxon always opposed the segregation of *Dryopteris*. So did that other conservative student, Mr. Weatherby, for many years, but he did

eventually change his mind. In response to my request for his opinion as to what treatment I should use in the new Illustrated Flora, he replied (Nov. 21, 1947): "As to your immediate problems, so far as the flora of north-eastern America is concerned I should be willing to accept *Thelypteris* and *Dryopteris* as separate genera, with *Gymnocarpium* as a very real difficulty, but probably to be placed with the former on habital grounds. There isn't any *Dryopteris* I can think of which has a running rootstock and solitary fronds. . . . I realize that I am far from definite; I haven't been able to make up my own mind yet."

Mr. Weatherby's opinions coincided with my own, except as to the disposition of *Gymnocarpium*. The generic name *Gymnocarpium* will be unfamiliar to many readers. The genus was described by Newman in 1851 and included three species, *G. Dryopteris*, *G. Robertianam*, and *G. Phegopteris*. As treated by Newman it was essentially the same as the genus *Phegopteris* (Presl) Fée, which must be typified by the beech-fern (*Polypodium Phegopteris* L.). Now, up to the present time certain writers, mostly those concerned with local floras, have maintained the genus *Phegopteris* to include both the beech-fern and the oak-fern (*Polypodium Dryopteris* L.). These two plants have in common an elongate, creeping rhizome and exindusiate sori. These two characters are obvious, but not fundamental ones in this group of plants. The beech-fern is closely allied in structure with typical *Thelypteris* (the marsh-fern). The oak-fern, on the contrary, differs widely. Ching realized this and published a paper entitled "On the Nomenclature and Systematic Position of *Polypodium Dryopteris* L. and Related Species."<sup>2</sup> He proposed that the oak-fern be regarded as a distinct genus, and revived the name *Gymnocarpium* for it, typifying the genus on *Polypodium*

<sup>2</sup> Contr. Biol. Lab. Sci. Soc. China 9: 30-43. 1933.

*Dryopteris*. He may be followed in this typification.

The oak-fern is intermediate in many ways between *Thelypteris* and *Dryopteris*. I found that I could hardly define either genus satisfactorily if it was included, but it seemed to be nearer to *Dryopteris*, contrary to Mr. Weatherby's suggestion. This observation agreed with Holttum's comments in his exceedingly valuable paper "A Revised Classification of Leptosporangiate Ferns."<sup>3</sup> Holttum places *Thelypteris* in a separate family (Thelypteridaceae) from *Dryopteris* which is placed in the Dennstaedtiaceae, tribe Dryopteridoideae. In commenting on *Gymnocarpium*, Holttum wrote: "*Gymnocarpium* has the rachis-pinnule characters of *Dryopteris* and its immediate allies, and scales like *Dryopteris*, for which reasons a relationship to *Dryopteris* is indicated, though *Gymnocarpium* has a simpler anatomy than *Dryopteris* and a creeping apparently dorsiventral rhizome. In any event, it is not near *Thelypteris* and needs further investigation."<sup>4</sup>

Mr. Weatherby finally agreed and wrote me (March 9, 1948) "Have you noticed that Holttum agrees with you in putting the oak-fern with *Dryopteris*? It has some traces of a new character which he uses for *Dryopteris*—grooved upper surface of the costae, as opposed to convex ones in *Thelypteris*. I somehow can't imagine that this is a very important character, but in the few species I have looked at it seems to hold. I am inclined to think that, if I had to write a fern-flora of this region, I'd

<sup>3</sup> Journ. Linn. Soc. Bot. 35: 123-158. 1946.

<sup>4</sup> In regard to putting *Thelypteris* and *Dryopteris* into different families Mr. Weatherby had this to say: "I cannot stomach these two as separate families, or even subfamilies. I do think you would be justified in keeping . . . Polypodiaceae until you have satisfied yourself as to how far and into what the other course is going to lead you. . . . I am still waiting for some phylogenist even to attempt to explain how so many lines of descent, from such different ancestors, managed to produce an almost perfectly uniform sporangial structure."

follow Ching (somewhat) and make a separate genus for the oak-fern. It seems to me to make difficult the definition of either *Dryopteris* or *Thelypteris*, if included.”

I distinguish these three genera as follows:

Acicular, unicellular hairs present on costae above; segments ciliate; stipe bundles two, these united below base of blade; rhizome scales ciliate (sometimes sparingly); rhizomes slender, creeping; fronds membranaceous; veins reaching the margin.

THELYPTERIS

Acicular hairs absent on costae above; segments not ciliate; stipe bundles free; rhizome scales not ciliate, sometimes toothed.

Lowest pinnae articulate to rhachis; stipe bundles two; veins reaching the margin; rhizomes slender, wide-creeping; blades membranaceous, deltoid; indusium none

GYMNOCARPIUM

Lowest pinnae not articulate; stipe bundles 3-7; veins ending short of the margin in elongate hydathodes; rhizomes thick, short-creeping to erect; blades herbaceous to coriaceous, ovate to lanceolate; indusium present

DRYOPTERIS

It should be emphasized that this key accounts only for the species of the northeastern United States. The inclusion of certain tropical groups would modify the key to some extent. I believe that *Cyclosorus* and *Goniopteris* should be included in *Thelypteris*. In the tropics there is also a third major genus, *Ctenitis*, to consider.

As to the name *Thelypteris*, it should be noted that Dr. Copeland<sup>5</sup> has revived the name *Lastrea* for this genus. He rejects *Thelypteris* on the ground that Schmidel did not use the binomial system of nomenclature and that he did not form a binomial. According to the Rules a genus may be validly described even though no species is named. The requirement that an author must be using the binomial system applies only to questions involving the validity of species names. It does not apply to generic names. Copeland states—“Of still more recent authors who adopt the name [*Thelypteris*], Alston, Kew

<sup>5</sup> Genera Filicum 135. 1947. Copeland includes *Gymnocarpium* in *Lastrea*.

Bull. (1932) 309, alone seems to have presented justification." Dr. Copeland evidently overlooked the paper by M. L. Fernald and C. A. Weatherby entitled: Schmidel's Publication of *Thelypteris*."<sup>6</sup> Fernald and Weatherby show conclusively that Schmidel's publication is valid. Professor Fernald does not use *Thelypteris* in his new account in Gray's Manual, because he continues to maintain the marsh-fern in *Dryopteris*, and *Dryopteris* is a conserved name. However, the conservation of *Dryopteris* over *Thelypteris* does not prevent the use of the latter when the two genera are held to be distinct.

Our two species of *Gymnocarpium* are not always easily distinguished. The character assigned by Milde and adopted by Hultén and others, namely "First pinnule on lower side of basal pinnae about equal in length to the third primary pinnae" [*G. Dryopteris*] as opposed to "first pinnule on lower side of basal pinnae about equal in length to fourth primary pinnae" [*G. Robertianum*] does not hold very well. The difference in the division of the blade is usually rather easy to observe but hard to express quantitatively. I find that the following holds fairly well:

|  |                       |
|--|-----------------------|
| First pinnule on lower side of basal pinnae about equal to one third of the total length of the frond [i.e. the length of the primary rhachis] or longer ..... | <i>G. Dryopteris</i>  |
| First pinnule on lower side of basal pinnae about one fourth as long as the frond or shorter .....   | <i>G. Robertianum</i> |

#### DRYOPTERIS

In my treatment of *Dryopteris* (i.e. *Eudryopteris*) I have recognized seven species: *D. fragrans*, *D. Filix-mas*, *D. marginalis*, *D. cristata*, *D. Goldiana*, *D. Clintoniana*, and *D. austriaca* (*D. spinulosa*). Small and some other botanists have recognized a number of others (e.g. *D. celsa*, *D. Boottii*, *D. atropalustris*, *D. separabilis*) which seem to be hybrids. Natural hybrids between these spe-

<sup>6</sup> Rhodora 31: 21-26. 1929.

cies were noted by Dowell<sup>7</sup> and Benedict.<sup>8</sup> The first two, *D. fragrans* and *D. Filix-mas*, mostly do not grow with the other species, so hybrids are consequently few; but the other species have apparently combined in almost all possible ways. Hybridity in these plants has been postulated chiefly on the basis of the possession of characters intermediate between the presumed parents, abnormalities, and putative sterility. A worthwhile discussion along modern lines is not possible at the present time. Such a study would require extensive genetic and cytological work.

At the same time it is scarcely to be doubted that natural hybrids do occur. Clinton's fern, *D. Clintoniana*, is recognized today either as a distinct species or as a variety of *D. cristata*. As Small points out, it is quite as much like *D. Goldiana* as *D. cristata*, a fact observable in the frequently abruptly acuminate blades, these only slightly reduced toward the base, the relatively large size of the plants, the larger, darker scales, and inframedial sori. It is more like *D. cristata* in the shape of the pinnae. It seems likely therefore that *D. Clintoniana* originated as a cross between *D. cristata* and *D. Goldiana*, and it therefore should not be regarded as a variety of *D. cristata*. It is perfectly fertile and reasonably constant; it is apparently an allopolyploid which can rank as a species. However, if this is true, it is evident that if *D. Clintoniana* is able to cross with other species, as seems likely, the resulting hybrids with *D. marginalis*, *D. austriaca*, and the back-crosses with *D. cristata* and *D. Goldiana* will defy analysis by ordinary herbarium techniques.

The most that can be done is to make guesses. From the abundant series of specimens collected in the Dismal Swamp area of Virginia by William Palmer and others

<sup>7</sup> Bull. Torr. Club 35: 135-140. 1908.

<sup>8</sup> Bull. Torr. Club 36: 41-49. 1909.

I would guess that the controversial plant described as *D. Goldiana* subsp. *celsa* W. Palmer (*D. celsa* Small) is *D. Clintoniana* × *Goldiana*, as suggested by Wherry (Guide to Eastern Ferns). Dr. Fernald (in the new Gray's Manual) has recognized it as a valid species.

Another critical plant, also described from the Dismal Swamp, is *D. atropalustris* Small. Dr. Wherry identifies this as *D. cristata* × *Goldiana*, i.e. the same cross that resulted in *D. Clintoniana*, but it does not look like *Clintoniana*. The type specimen in the New York Botanical Garden does not show characters of *cristata*, but seems to me to have an evident strain of *D. marginalis*. I take it to be *D. Goldiana* × *marginalis*.

Another dubious plant is *D. Clintoniana* var. *australis* Wherry (*D. australis* Small), originally described from Alabama, but now reported from North Carolina, Louisiana, and Arkansas. Here again I see a strain of *D. marginalis* present, and there is a suggestion also of *D. ludoviciana* and *D. Clintoniana*. The plant may be, as Wherry diffidently suggested, a mixture of several species. Some other hybrids have received specific names (among them *D. Slossonae*, *D. pittsfordensis*, *D. separabilis*, *D. Boottii*).

From the above it might seem that the eastern United States population of wood-ferns is a "hybrid swarm," but such is scarcely the case. The great majority of plants in any locality are obviously referable to one or other of the basic species. The hybrids in most cases are rare or local.

DRYOPTERIS AUSTRIACA (Jacq.) Woyнар ex Schinz & Thell. Vierteljahrssch. Naturf. Ges. Zürich 60: 339. 1915.

In Christensen's Index Filicum, *Polypodium austriacum* Jacq.<sup>9</sup> is referred with a query to *Dryopteris spinulosa*. Later Woyнар transferred the species to *Dryop-*

<sup>9</sup> Obs. Bot. 1: 45. 1764.



*teris*. Since *austriacum* has priority over *Polypodium spinulosum* Müll. it must be adopted for our spinulose shield-ferns if it really applies to this group. The original description is as follows (translated) :

*Polypodium austriacum*. Fronds decomposed, pilose; leaflets [i.e. pinnules] opposite or alternate; pinnae [segments] pinnatifid, lanceolate, the lower opposite and distant, the upper alternate and confluent into a leaflet; stipe lanuginose at base.

Habitat in subalpine woods of the Etsch. Fruits in October. Frond about 2 feet long, composed of about 8 opposite leaves [pinnae] and 3 terminal, the lowest [pinnae] about 8 inches long, the others decreasing in size. These themselves [i.e. pinnae] are bipinnate and composed of numerous alternate leaflets [i.e. pinnules], the lower often opposite, the longer about 3 inches long, the others decreasing in size. On these [pinnules] are placed pinnae [segments] at intervals of 3 or 4 lines, these obtuse, the larger 10 lines long, pinnatifid, the angles and sinuses obtuse, the lower opposite, the upper alternate and confluent. The petioles are all pilose, the pinnae and stipe less so; but this [stipe] at the base is enveloped in a silky wool.

It must be remembered that in 1764 fern terminology had not been standardized. A check with all the ferns growing in the Alps shows that *Dryopteris dilatata* is the only fern that corresponds at all with this description, and that it does agree in most respects. The description of the fronds as "pilose" is confusing, but I judge that Jacquin was referring to the scales; this is more or less shown by his statement that the base of the stipe is enveloped in a "silky wool"; this "wool" could only be the conspicuous basal scales of *Dryopteris dilatata*. It has been tentatively suggested that possibly Jacquin had a flowering plant rather than a fern in hand, but I do not believe that this is credible. Jacquin was a distinguished and accomplished botanist. He was unquestionably familiar with the genus *Polypodium* in the Linnaean

sense.<sup>10</sup> If his material had been sterile one might have some vague doubts, but he says "fruits in October" and he surely knew the difference between the fruit [dots] of *Polypodium* and the fruit of any flowering plant.

The name *Dryopteris austriaca* has been adopted by several European botanists and by Hultén in his "Flora of Alaska." It is unfortunate that the well-known name *D. spinulosa* should be displaced, but there does not seem to be any alternative.

The varieties will be known as follows:

DRYOPTERIS AUSTRIACA var. DILATATA (Hoffm.) Fiori,  
Flora Italica Cryptogama 5: 117. 1943.<sup>11</sup>

DRYOPTERIS AUSTRIACA var. SPINULOSA (Müll.) Fiori,  
Flora Italica Cryptogama 5: 115. 1943.<sup>12</sup>

DRYOPTERIS AUSTRIACA var. **intermedia** (Muhl.) Mor-  
ton, comb. nov. *Polypodium intermedium* Muhl. ex  
Willd. Sp. Plant. 5: 262. 1810.

DRYOPTERIS AUSTRIACA var. **fructuosa** (Gilbert) Mor-  
ton, comb. nov. *Nephrodium spinulosum fructuo-*  
*sum* Gilbert, List No. Amer. Pterid. 37. 1901.

DRYOPTERIS AUSTRIACA var. **concordiana** (Davenp.)  
Morton, comb. nov. *Nephrodium spinulosum* var.  
*concordianum* Davenp. Rhodora 6: 33. 1904.

#### WOODSIA

WOODSIA OREGANA D. C. Eaton var. **Cathcartiana** (B. L.  
Rob.) Morton, comb. nov.

*Woodsia Cathcartiana* B. L. Rob. Rhodora 10: 30.  
1908.

Since the time of its original discovery by Miss Ellen Cathcart at Taylor's Falls of the St. Croix River, Minne-

<sup>10</sup> It will be recalled that Linnaeus placed such plants as *Dryopteris marginalis* in *Polypodium*.

<sup>11</sup> Fiori attributed this combination to Underwood (1893), obviously an error. It may be that Fiori's varietal combination is not the earliest, but I have been unable to find another. Schinz and Thellung made the combination *D. austriaca* subsp. *dilatata*.

<sup>12</sup> Attributed to Kuntze (1891) in error. Schinz and Thellung made the combination *D. austriaca* subsp. *spinulosa*.

sota, in 1874, *Woodsia Cathcartiana* has puzzled fern students. D. C. Eaton originally referred the specimen to his *W. scopulina* (in Gray's Manual, ed. 6, 691. 1890), but B. L. Robinson realized that it was different and described it as new.

Recently Dr. T. M. C. Taylor<sup>13</sup> has considered it a variety of *W. pusilla* Fourn. (1880).<sup>14</sup> *Woodsia Cathcartiana* does resemble *W. mexicana* [*pusilla*] in many ways, but it is even closer to *W. oregana* D. C. Eaton, as noted by R. M. Tryon, Jr.;<sup>15</sup> in fact, these two are separable only with difficulty and by characters of probably secondary importance. The rhachis and costae of *W. oregana* are very sparingly glandular and the leaf surface entirely eglandular, whereas these are conspicuously glandular in *W. Cathcartiana*. The indusial segments in *W. Cathcartiana* are rather long (but by no means so long as in *W. mexicana*), and often overtop the sporangia. Those of *W. oregana* are shorter and mostly concealed; they are variable, sometimes principally of beadlike cells,<sup>16</sup> but more often broader and hairlike only at the tip.

Dr. Taylor<sup>17</sup> indicates that true *W. oregana* is eglandular in all stages and describes a f. *glandulosa*, based on material from Ontario, for those plants exhibiting glands. However, all specimens that I have examined, including those from Oregon, show some capitate-glands, although these may be very few and most noticeable at

<sup>13</sup> Amer. Fern Journ. 37: 86. 1947.

<sup>14</sup> Taylor uses the name *pusilla* in place of *Woodsia mexicana* Fee (1875), on the ground that the latter is a later homonym of *W. mexicana* R. Br. (in Wall. Pl. As. Rar. 1: 41. 1830), but the latter is a *nomen nudum* and cannot be considered in matters of priority.

<sup>15</sup> Amer. Fern Journ. 38: 168. 1948 [1949].

<sup>16</sup> As illustrated by Maxon, in Abrams' Illustrated Flora of the Pacific States.

<sup>17</sup> *Op. cit.* 85.

the bases of the pinnae. It seems, therefore, that *f. glandulosa* may be disregarded.

It seems, therefore, that *Woodsia Cathcartiana* is best considered as only a somewhat geographically isolated variety of *W. oregana*, although it must be admitted that the interrelationships in the section *Perrinia* are far from satisfactorily settled.

WOODSIA SCOPULINA D. C. Eaton var. **appalachiana** (T. M. C. Taylor) Morton, comb. nov.

*Woodsia appalachiana* T. M. C. Taylor, Amer. Fern Journ. **37**: 88. 1947.

The fern from the Allegheny Mountains which has commonly been referred to *W. scopulina* has been characterized as a new species by Professor T. M. C. Taylor. Although fern students have realized that it differs from typical western specimens of *W. scopulina*, the differences have not seemed conspicuous or fundamental. The rhizome scales are somewhat narrower and the indusial segments broader, but the plants agree with *W. scopulina* in so many features, in particular, in dissection and in the presence of long, articulate hairs on the costae and costules of the pinnae, that they seem better treated as a geographically isolated variety. The variety is rare and found only in a limited area in the Allegheny Mountains in Virginia, West Virginia, North Carolina, and Tennessee; there is an outlying station in the Ozark Mountains in Arkansas.

WOODSIA OBTUSA (Spreng.) Torr. In Broun's Index to North American Ferns, *W. obtusa* is said to range from Alaska to British Columbia. So far as I know this statement has no basis in fact, but strangely enough it appears again and again, e.g. in Maxon in Britton and Brown, Illustrated Flora, in Small's Ferns of the Southeastern States, in Wherry's Guide to Eastern Ferns, in Tryon *et al.* Ferns of Wisconsin, in Brown and Correll,

Ferns and Fern Allies of Louisiana, in Ogden's Ferns of Maine, and elsewhere. All these records apparently go back to a misidentification by William Trelease as *W. obtusa* of an Alaskan specimen of *Cystopteris fragilis*. The Arizona record of Broun is based on a misidentification of *W. Plummerae*. The range is correctly stated by Professor Fernald in the new Gray's Manual.

## ATHYRIUM

ATHYRIUM THELYPTEROIDES (Michx.) Desv. The silvery-spleenwort is widely distributed in the eastern United States, although not exactly common. There are two forms, in their extreme development almost suggesting two species—the typical form, which is the commonest and most widespread, has the segments of the pinnae with nearly straight, scarcely toothed sides and a rounded or subtruncate apex; the veins are mostly simple and the indusia rarely athyrioid; the other form, known as f. *acrostichoides* (Swartz) Gilbert, is more northerly in range, being known chiefly from Quebec to northern New England, west to Ontario and Wisconsin; it has broader, strongly toothed segments, with curved sides, and an obtuse or acutish tip; the veins are often forked in the sterile blades and the indusia are more often athyrioid. These two forms have been noted occasionally,<sup>18</sup> but apparently no serious field study has been made. Authors have assumed by their recognition of *acrostichoides* as merely a form, that these variations have little genetic significance but are ecological adaptations, but this remains to be demonstrated. It is particularly desirable to collect young stages as well as mature plants. These ferns should prove a suitable subject for "mass collecting" and statistical analysis.

*To be continued.*

<sup>18</sup> Cf. Gilbert, Fern Bull. 8: 9. 1900; Winslow, Amer. Fern Journ. 1: 79-82. 1911; Weatherby, Amer. Fern Journ. 26: 131-132. 1936; Gruber, Amer. Fern Journ. 27: 27. 1937.